# The Mwangaza Project:

# A Comprehensive Report on the Nationwide Baseline Survey of Technology Skills for Learners with Vision Impairment in Kenya

Georgia Tech School of Psychology Tech Report GT-PSYC-TR-2016-01

**Bruce N. Walker, PhD**

December, 2016

*With Contributions from Mwangaza Project Leads:*

**Bruce N. Walker, PhD**

**Irene Mbari-Kirika, MBA, OGW**

**Marguerite Miheso-O'Connor, PhD**

## 1 Document Overview

This document presents the results of a major portion of the PEER-funded collaborative research project called the Mwangaza Project. The project is a shared effort between: the Sonification Lab at the Georgia Institute of Technology ("Georgia Tech") in Atlanta, USA; inABLE, a non-profit organization based in Nairobi, Kenya, and Washington DC, USA; and Kenyatta University, in Nairobi. This research team has completed a two-phase project including (1) a nation-wide survey of the interests, needs, skills, and opinions of blind students and their teachers, with respect to information and communications technology (ICT, aka "technology"); and (2) initial development, deployment, and evaluation of some novel assistive technologies that represent potential new approaches to STEM education for students with vision loss. This report describes the baseline survey of students and teachers.

## 2 Mwangaza Project Overview

For many years, Prof. Bruce Walker's Sonification Lab at Georgia Tech has grappled with how to make data -- and thereby Science, Technology, Engineering, and Mathematics (STEM)-- more accessible to blind students and workers. The main focus in this line of research has been the study of auditory graphs and the development of software tools to support the use of multimodal data displays in the classroom. Over the past few years, Dr. Walker has completed field studies at the Georgia Academy for the Blind in Macon, GA, in which Sonification Lab software, hardware and methods were deployed and studied in middle school Math classes. That work has led to several novel software tools and educational approaches that hold great promise for STEM education amongst learners with visual impairment. These software tools, such as MathGENIE (Chew, Davison, & Walker, 2014; Chew, Tomlinson, & Walker, 2014; Davison, Suh, & Walker, 2012) and the Sonification Sandbox (Davison & Walker, 2007; Walker & Cothran, 2003; Walker & Lowey, 2004) have been shown to enable math and STEM education and improve efficiency for the teachers (Tomlinson, et al., 2016).

> ***"While there have been projects in the past aimed at helping educate blind students in Kenya (and elsewhere), and some projects that have attempted to make computers more available, none that we are aware of has the blend of education research, technology, training, and accessibility, rolled together with the deployment of both computer labs and training, and with the support of major research universities, corporations, and the government's education department. We hoped that this would be a truly transformative project, on an international scale."***

The Sonification Lab researchers considered that perhaps these benefits could be realized by a much larger group of learners, perhaps even across developing nations, if the tools and techniques were more broadly deployed. It is important to note, though, that the students and teachers involved in the Sonification Lab's research were computer-literate and had access to modern computers, as well as to assistive technology including electronic devices as well as Braillers and other resources. While the potential for widespread benefits is clear, it is crucial to be able to leverage a population of learners and teachers with knowledge, desire, and access to technology. This is a particularly challenging constraint in a country such as Kenya, where technology and ICT skills can be scarce.

Over the same period of time, the past 6-7 years, the Kenyan nonprofit organization inABLE, led by Ms. Irene Mbari-Kirika has been tackling the vexing problem of technology availability and skills in Kenya, particularly amongst students with vision loss. inABLE's mission is to empower the blind and visually impaired in Africa through technology. inABLE accomplishes this mission by establishing computer labs and providing computer skills training in special schools for the blind in Kenya. inABLE has developed and refined entire curricula to train visually impaired students in all aspects of technology use, from what a computer is and how to turn it on, through the use of basics like email and web browsing, into productivity software such as Microsoft Office, accessing digital books, and even to more advanced topics like Web page design and Java programming. The ultimate vision, of course, is that once a (Kenyan) school has a computer lab, and students and teachers are trained to use the technology, STEM education tools can be deployed to expand the education of those students. The combination of marketable computing skills and a better, more complete education (including STEM topics) will improve the careers and lives of blind individuals across Kenya.

When inABLE started their program in 2009, there was no information available about similar projects in Kenya and Africa. Indeed, the inABLE computer skills training program was a very novel concept in Kenya, so inABLE had to rely on US-based case studies to learn how to implement such a program. There was also a clear absence of *data* in Africa on technology skills for children with vision loss; and certainly no comprehensive surveys of technology usage. To ensure that inABLE was able to measure the progress of their efforts over time, and to allow them to document lessons learned, they began to plan for more systematic data collection efforts. Data were crucially needed, both from within the inABLE project, and from across Kenya, even across Africa.

Clearly, there is the potential for great synergy between Georgia Tech, who are developing accessible software tools that can be used in education, and inABLE, who are preparing the blind students in Kenya (and their teachers) to be ready to take advantage of such tools. However, the tools and methods deployed must be developed with the local context in mind. Thus, inABLE and Georgia Tech have been working together to identify needs and goals for new software tools. Both organizations are deeply committed to documenting the effectiveness of their projects, through systematic data collection efforts.

To ensure that there is careful attention being paid to the Kenyan context, and to assist in research related to the Mwangaza project goals, inABLE and Georgia Tech invited partners at Kenyatta University in Nairobi (now led by Dr. Marguerite Miheso-O'Connor) to collaborate and contribute to the research, and possibly the development aspects of the project. With funding from the USAID/NSF PEER program (Partnerships for Enhanced Engagement in Research, an "*international grants program that funds scientists and engineers in developing countries who partner with U.S. government-funded researchers to address global development challenges*"[1]), this diverse project team has worked to identify the specific needs of the Kenyan students with vision loss and their teachers, to help inABLE tweak its computer training program and Georgia Tech to adjust (or develop) tools and resources that will be appropriate for blind and low-vision Kenyan learners, to enhance the training efforts of inABLE, and collect substantial data throughout.

[1] PEER Program Web page on the USAID site:
https://www.usaid.gov/what-we-do/GlobalDevLab/international-research-science-programs/peer

## 3 Planned Phases of the Project

As the collaboration took shape, it became clear that there were three main phases that were needed to start things off. First, it was important to understand the experience of blind students in Kenya with respect to technology, their perspectives on career choices, aspirations, and other psycho-social measures. There is a critical need to understand this space. We realized, of course, that most of the students in Kenya have very little technology experience and very few resources, but this needs to be documented and assessed so it can be addressed. This state of technology experience would also be critical as a baseline against which the success of the project could be measured. However, there were simply no such data available! Clearly, then, we needed to conduct a nation-wide baseline survey of the technological skills and experience of the blind and low vision students in Kenya. We also need to include other stakeholders such as teachers who work with blind and low-vision learners. This data collection required a concerted effort by Georgia Tech, inABLE, and Kenyatta University.

Then, the second phase of the project was to deploy GT Sonification Lab STEM education software, curriculum, etcetera, at some Schools for the Blind in Kenya (e.g., Thika Primary and then Thika Secondary school), along with appropriate training and practice, in the inABLE-operated computer programs. This would leverage and extend the training that inABLE has been conducting, and begin to develop tools and plans for using technology in STEM education. To assess the effectiveness of the project, the plan (beyond the scope of this current project) is to repeat the nation-wide survey after more computer training programs have been implemented, and additional STEM tools had been deployed. We predict that not only will there be gains in computer skills and STEM knowledge, but also improvements in career aspirations and students' perspectives on their role in society. The first two phases of this project have been implemented (and are reported in this document); we are already following up this first project with new projects to conduct additional software development and deployment, for a range of tools related to weather, educational games, and mathematics education, among others.

Finally, we plan to develop a training program to teach employable skills (e.g., software programming; Web Accessibility Assessment), showcasing the fact that (blind) students are able to seek technology-supported employment. Those efforts have proceeded, but separately, under the auspices of inABLE, with some input from Georgia Tech. That has all been outside of the remit of this PEER-funded project; as such, it will not be discussed further in this report.

## 4 Further Background in Assistive Technology and STEM Education

Every day we need to understand data in order to make choices in our lives. For people with vision loss, the typical graphical presentations of data may be difficult or impossible to access. As a result, education and employment are difficult for blind individuals, especially in STEM fields. Assistive technology has the potential to bridge the learning divide among learners from different backgrounds, allowing teachers and students access to critical information (both within and beyond the classroom).

The development and deployment of assistive technology, training, and STEM education tools for the blind can clearly have dramatic impact in the USA, and an even larger impact in developing countries such as Kenya, where the incidence of vision loss is much greater, especially among school-aged children. Unfortunately, technology and STEM education for the visually impaired in Kenya has been constrained by a lack of resources and experience. Indeed, even though Kenya's school system includes at least twelve (12) schools specifically for the blind, each with hundreds of students; plus thousands of additional low-vision students who attend "integrated" public schools, there are still many more children with vision loss who simply never attend school at all. And for those who do go to school, there is extremely little in the way of computer resources or training. Thus, it is not at all surprising that even a quick observation confirms that learners with disabilities remain largely absent from mainstream STEM related courses at tertiary levels, such as at Kenyatta University.

*While there have been projects in the past aimed at helping educate blind students in Kenya (and elsewhere), and some projects that have attempted to make computers more available, none that we are aware of has the blend of education research, technology, training, and accessibility, rolled together with the deployment of both computer labs and training, and with the support of major research universities, corporations, and the government's education department. We hoped that this would be a truly transformative project, on an international scale.*

We note that the research reported in this document is limited to learners currently within the Kenyan education system (school and university). It does not include learners who have completed their education; are out of school; or who never entered the school system.

Nevertheless, as any large project needs to start somewhere, for us the Thika Primary School for the Blind was the launching point. Thika was the first school to have a computer lab set up by inABLE, and is the home to inABLE's highly successful computer training program. There are inABLE staff onsite at the Thika School, and as a result of all this, relatively good computing facilities and network access, plus a growing number of (blind) students and (sighted and blind) teachers with computing skills. inABLE is already replicating and extending their successful computer program from Thika to other special schools for the blind in Kenya. We decided to use Thika as the initial location for development of new tools, testing of integration into teaching, and the development of surveys and other research materials.

The tools and instructional approaches deployed at Thika will expand on the successful resources and methods developed by the GT Sonification Lab, through their NSF-sponsored research in the USA. Careful requirements analyses, plus iterative design with the active participation of all stakeholders, has led to tools and methods that use technology to help blind students go far beyond the STEM learning they had previously, and do so faster and with more active practice. In fact, GT-developed auditory graphing software, along with bone-conduction audio headsets, has changed the way math teachers at the Georgia Academy for the Blind (GAB) interact with their students, allowing the teachers to spend less time lecturing, and allowing the students to spend more time interacting with each other and with the teacher, during more hands-on practice, exploration, and learning. There could be much to borrow from that, in the Kenyan context.

# 5 Nation-wide Baseline Survey of Students

This report presents the results of a nationwide survey of blind and low-vision students at schools across Kenya, completed in the spring of 2015 as part of the Mwangaza Project. The purpose of the survey was to begin to collect data about learners in Kenya with vision loss, particularly at all of the Schools for the Blind, but also at some integrated public schools. In addition to demographic information, the survey included questions about computer and technology experience, interest in computer training, and various measures of life satisfaction, psychosocial status, and career aspirations. To our knowledge this is the first comprehensive survey involving students with vision loss in Kenya, and should serve as an effective baseline against which to assess the efficacy of computer training programs, and projects to deploy assistive technology as part of classroom education for this population. Subsequently, additional data have been collected from older undergraduate students with vision loss, at Kenyatta University, and from teachers who work with blind and low-vision students. Those supplemental data are described in later sections of this report.

## 5.1 Data Collection Method

The method of research used during the data collection was both interview and questionnaire oriented. Teams of researchers were deployed to 11 schools for blind students in Kenya, as well as 6 integrated public schools.

***Table 5.1. Special Schools in Kenya Visited for this Baseline Survey***

| | School Name | Year Estab | Sponsor | Type | Impairment | County | Day / Boarding | Curriculum |
|---|---|---|---|---|---|---|---|---|
| 1 | St. Oda Primary | 1961 | Catholic | Public | Blind & Low vision | Siaya | Boarding | Regular |
| 2 | St. Oda Secondary (1) | 1961 | Catholic | Public | Blind & Low vision | Siaya | Boarding | Regular |
| 3 | Thika Primary | 1946 | Salvation Army | Public | Blind & Low vision | Thika – Kiambu | Boarding | Regular |
| 4 | Thika High School | 1967 | Salvation Army | Public | Integrated | Thika – Kiambu | Boarding | Regular |
| 5 | St. Lucy's Primary | 1958 | Catholic | Public | Integrated | Eastern – Meru | Day & Boarding | Regular |
| 6 | St. Lucy's Secondary | 2008 | Catholic | Public | Integrated | Eastern – Meru | Boarding | Regular |
| 7 | Likoni School | 1965 | Salvation Army | Public | Blind & Low vision | Coast – Mombasa | Boarding | Regular |
| 8 | St. Francis Primary | 1979 | Anglican Church | Public | Blind & Low vision | North Rift – Kapenguria | Boarding | Regular |
| 9 | St. Francis Secondary | 1979 | Anglican Church | Public | Blind & Low vision | North Rift – Kapenguria | Boarding | Regular |
| 10 | Kibos Primary | 1963 | Salvation Army | Public | Blind & Low vision | Kisumu | Boarding | Regular |
| 11 | Kibos High | 2008 | Salvation Army | Public | Blind & Low vision | Kisumu | Boarding | Regular |

Note 1: St. Oda Secondary is now known as NICO HAUSA Secondary School for the Blind, established in 2014.

*Table 5.2. Integrated Schools in Kenya Visited for this Baseline Survey*

| No. | School Name | County |
|---|---|---|
| 1 | Central Primary School | Kitui |
| 2 | Muslim Primary School | Kitui |
| 3 | Kambi ya Juu Primary School | Isiolo |
| 4 | Kilimani Primary | Nairobi |
| 5 | Moi Girls Secondary | Nairobi |
| 6 | Aquinas Secondary | Nairobi |

The process entailed direct interaction with participants (pupils) on a one-on-one basis through interviews with researchers. Teams of researchers visited the schools, and interacted with nearly every student with vision loss, using Computer Assisted Personal Interviewing (CAPI). CAPI is a computer assisted data collection method for replacing paper-and-pen methods of survey data collection, and is usually conducted at the home or business (in this case, the school) of the respondent using a portable personal computer such as a tablet. The researchers read aloud questions from a survey, and record the students' individual answers into a software application on the tablet computer (see detailed procedures, below). Effective use of CAPI often results in quick turnaround surveys, as was the case in this project. Albeit labor-intensive, this data collection approach provided many benefits. For example, the data collected are much richer, include fewer errors and ambiguities, and enable a deeper insight into the actual views of the students than if the students were simply left on their own to complete a survey. All researchers involved in this project have completed a research ethics course offered online by the Collaborative Institutional Training Initiative (CITI: https://www.citiprogram.org), and comply with the requirements of the Georgia Tech Institutional Review Board (IRB).

## 5.2 Participants

Students with vision impairment, from nursery to secondary school, were the main subjects of the study (see Tables 3-5), though in subsequent phases we also included some undergraduate students (see Section 6, below). The study at the primary and secondary schools cut across from age 5 to 24 years and in some places like Kisumu there was a student at 40 years in Form One. Participants who were engaged in the process were expected to understand the purpose of the study and voluntarily take part, after a careful process of informed consent.

The students were given an explanation of the reasons for the study and its potential benefits to the visually impaired and society as a whole. They were asked to voluntarily take part in the process, and documented their consent and assent verbally or via appropriate forms. The purposes of the study included: an assessment of the students' experience with, and knowledge of technology; their career aspirations and interests in learning technology; and to begin to probe their attitudes towards their role in society (and whether technology might help improve things). The following tables provide some descriptive frequencies of how many students were in each grouping for all of the comparisons we are interested in.

### *Table 5.3: Number of Students By Grade Level*

| | Frequency | Percentage of Study Total |
|---|---|---|
| Nursery | 203 | 13.1 |
| Class 1 | 91 | 5.9 |
| Class 2 | 95 | 6.1 |
| Class 3 | 102 | 6.6 |
| Class 4 | 106 | 6.8 |
| Class 5 | 100 | 6.4 |
| Class 6 | 116 | 7.5 |
| Class 7 | 128 | 8.3 |
| Class 8 | 132 | 8.5 |
| Form 1 | 152 | 9.8 |
| Form 2 | 117 | 7.5 |
| Form 3 | 117 | 7.5 |
| Form 4 | 92 | 5.9 |
| **TOTAL** | **1551** | **100 %** |

### *Table 5.4: Number of Students by Gender*

| | Frequency | Percentage of Study Total |
|---|---|---|
| Male | 857 | 55.3 |
| Female | 681 | 43.9 |
| No Response | 13 | 0.8 |
| **TOTAL** | **1551** | **100 %** |

*Table 5.5: Number of Students At Each School*

| | Number of Students | Percent |
|---|---|---|
| Thika Primary for the Blind | 271 | 17.5 |
| Thika Secondary for the Blind | 212 | 13.7 |
| St. Oda Primary for the Blind | 157 | 10.1 |
| St. Oda Secondary for the Blind (1) | 59 | 3.8 |
| Kibos Primary for the Blind | 118 | 7.6 |
| Kibos Secondary for the Blind | 82 | 5.3 |
| St. Lucy's Primary for the Blind | 197 | 12.7 |
| St. Lucy's Secondary for the Blind | 66 | 4.3 |
| Likoni Primary for the Blind | 103 | 6.6 |
| St. Francis Primary for the Blind | 114 | 7.4 |
| St. Francis Secondary for the Blind | 46 | 3.0 |
| | | |
| Kitui Integrated Primary | 49 | 3.2 |
| Nairobi Integrated Primary | 22 | 1.4 |
| Nairobi Integrated Secondary | 4 | 0.3 |
| Moi Nairobi Girls Integrated Secondary | 4 | 0.3 |
| Kambi ya Juu Integrated Primary | 11 | 0.7 |
| | | |
| Total | 1515 | 97.7 |
| Missing | 46 | 3.0 |
| **TOTAL** | **1551** | **100.0** |

Note 1: St. Oda Secondary is now known as NICO HAUSA Secondary School for the Blind, established in 2014.

## 5.3 Materials / Apparatus

A team of experts from Georgia Tech, inABLE, and Kenyatta University came up with a well-structured quantitative interview questions (see Appendix A). This was computerized with help of data collection tablets running the Android operating system equipped with global positioning system (GPS) location sensors and Internet connections. Data were collected, geo-tagged, encrypted using industry-standard protocols, and sent directly into a database on a secure server, making the process quite reliable and efficient. The data collection hardware, software, and servers were provided by Infotrak Research & Consulting (http://www.infotrakresearch.com), a Kenyan survey and data collection company.

## 5.4 Procedure

A clear procedure was followed during this whole exercise:

- On arrival, Meeting with the school Administration for formal overview of the study (prior approval had been arranged by Kenyatta University and inABLE working through the Ministry of Education).
- Signing of the Consent form for the exercise on behalf of the school (acting *in loco parentis* for students).
- Introduction to the participants and general briefing on the study objectives and goals.

- Preparation of the participants and venue.
- We got assistance from some of the teachers who were bringing the participants from their classrooms to the Interview. However in some schools like Kisumu, Interviewers went to get the students from classes themselves.
- In some cases some of the participants opted not to take part in the study as this was clearly stated in orientation that it was voluntary and one would walk away if they did not feel comfortable participating.
- Reading and understanding of the assent/consent form (individually for older students, and group signing for the lower primary under age 10).
- Grouping the participants according to their grade/level of study.
- Begin of the interview where brief instruction is read before answering the multiple choices questions.
- Participant name and demographics data are filled into the tablets.
- Begin of actual interview with the participant which took approximately 20 – 25 minutes per interview. The researcher carefully read the questions and multiple choices provided, then recorded the choice selected by the interviewee.
- Participants who didn’t understand the language were assisted by their immediate class teachers through interpretation of the question before making a choice.
- On completion, questionnaire is saved and sent to a central server at the Infotrak data center.
- The process is repeated till all the participants are engaged.
- Finally all the Interviewers through their team leaders held the last meeting with the school Administration to inform them on how the process was and also thanked them before leaving.

## 5.5 Results from Nationwide Survey of Students With Vision Loss

### *5.5.1 Overview*

All data were analyzed using IBM's Statistical Package for Social Sciences (SPSS) software. Responses from all students who participated were anonymized and compiled into a master response list. There were a total of 1551 valid cases used for analysis. Any missing response data was coded as missing and omitted for that portion of analysis.

### *5.5.2 Composite Scores*

To look for trends in students' responses a series of composite scores were created. These scores were created out of subsets questions on the questionnaire. Individual scores from each item within the composite groups were added together for the composite score. We took this approach to make it easier for group comparisons and for looking for overall trends.

### *5.5.3 Self-Reported Visual Difficulties Scale*

We did not want to directly ask the students about their level of visual impairment, mainly because this may have been somewhat difficult for every student to specify. Instead we created a composite score from six of the questionnaire items that ask each student about how much difficulty she or he may experience with various tasks (Questions 1 through 6 in Appendix A). The *Self-Reported Visual Difficulties* score is a sum of questions 1 through 6 on the questionnaire. These are on a 5-point Likert scale, so these scores have a possible range between 6 and 30 in that "No trouble with visual tasks" = 6; "Extreme difficulty with visual tasks" = 30.

| | |
|---|---|
| Number of valid cases | 1545 |
| Missing / Omitted cases | 22 |
| Mean | 15.77 |
| Possible range of scores | 6 to 30 |
| Standard Deviation | 5.157 |

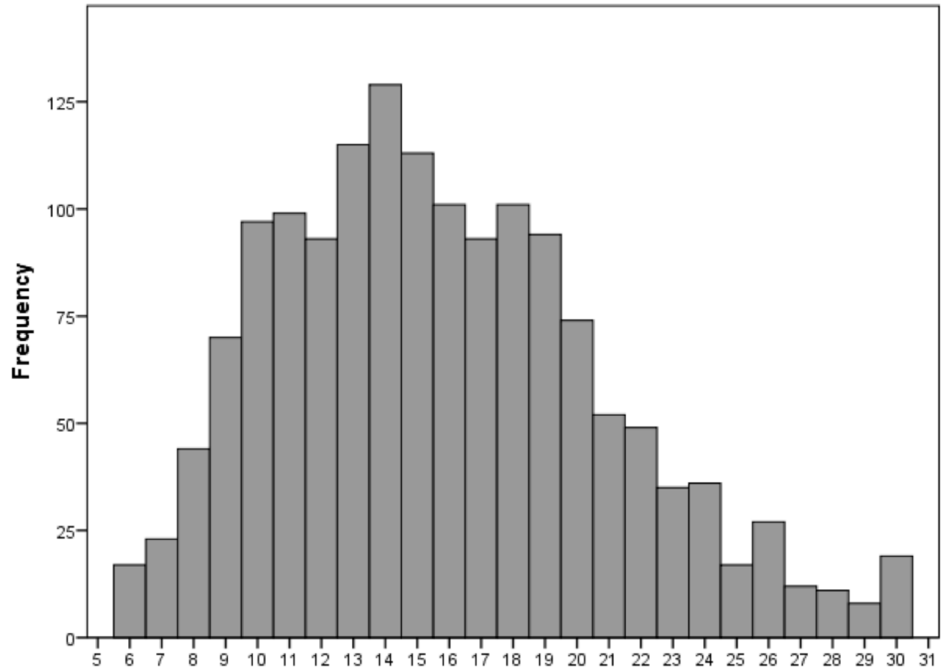


***Figure 5.1. Frequency distribution (vertical axis) for responses from all students on the Self-Reported Visual Impairments Scale (horizontal scale).***

### *5.5.4 Perceived Burden Scale*

Two of the questions (Questions 7 & 8 in Appendix A) ask how the students feel about themselves; "I feel ashamed or embarrassed…" and "I often feel that I am a burden on others…". These are both on a 6-point Likert scale from 1 (strongly disagree) to 6 (strongly agree) with the statement. The purpose of these questionnaire items is to establish the level of students' self worth. If these scores started out high we would hope they lower over time, and if they stared low we will look to keep them low. This all would indicate that students would tend to see themselves as less of a burden to others as they become more proficient at using computers. The composite score for *Perceived Burden* is on a scale from 2 to 12.

| | |
|---|---|
| Number of valid cases | 1491 |
| Missing / Omitted cases | 76 |
| Mean | 5.29 |
| Possible range of scores | 2 to 12 |
| Standard Deviation | 2.939 |

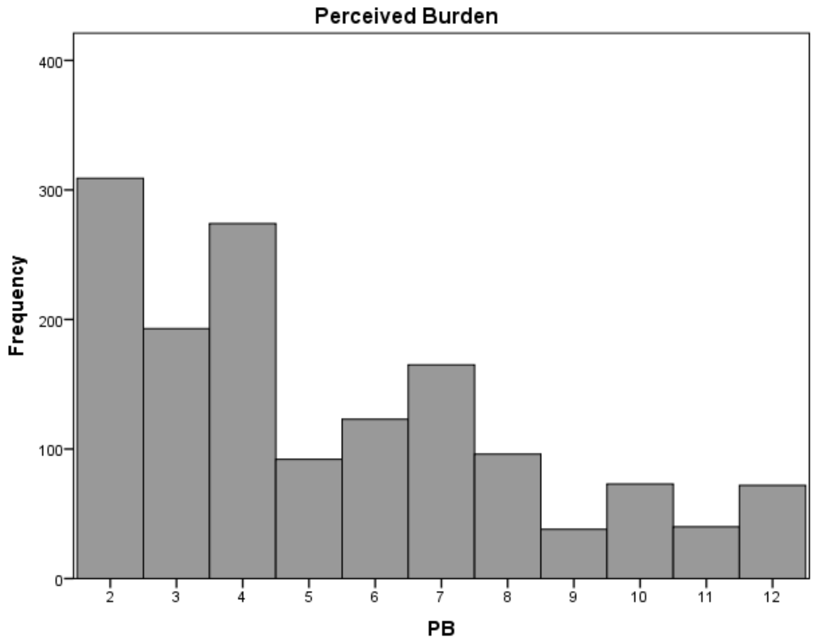


***Figure 5.2. Frequency distribution for responses from all students on the Perceived Burden Scale.***

### 5.5.5 Interest in Training Scale

This composite score was created by a sum of all the item responses for questions that asked students about how important or useful they think it would be to learn about computers. There were 9 items total (Questions 9, 10, 11, 17, 18, 19, 24, 25, and 26 in Appendix A). Some of the questions were negatively worded, so these questions were reversed scored (questions 10, 17, and 19). Responses for the *Interest in Training* score ranged from 9 at the lowest to 54 being the highest amount of interest.

| | |
|---|---|
| Number of valid cases | 1420 |
| Missing / Omitted cases | 147 |
| Mean | 45.92 |
| Possible range of scores | 9 to 54 |
| Standard Deviation | 5.566 |

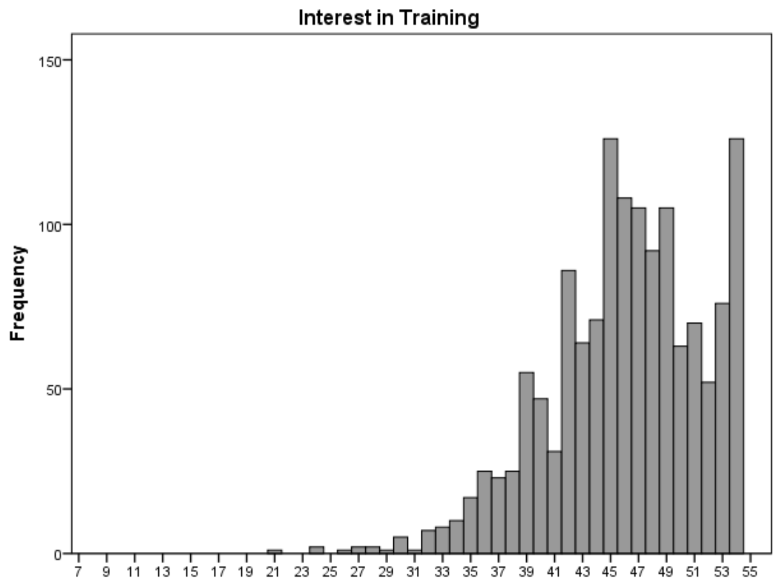


***Figure 5.3. Frequency distribution for responses from all students on the Interest in Training Scale.***

### *5.5.6 Computer Confidence Scale*

The Computer Confidence composite score was created from the sum of the 6 items that ask about how much confidence the students have in their own ability to learn to use a computer (Questions 12, 13, 14, 15, 16, and 22 in Appendix A). Some of these questions (12, 14, 16, and 22) were negatively worded so those items were reverse scored before creating the composite. *Computer Confidence* score ranged from 6 at the lowest to 36 as the highest amount of confidence.

Based on attitude—behavior theory, it has been hypothesized that computer use would enhance beliefs about self-perceived computer confidence, which would in turn affect attitudes towards computers. A study by Levine (1998) on self-report surveys that measured these three constructs revealed that (a) computer use positively affected computer confidence, and (b) computer confidence positively affected computer attitudes. Unexpectedly, direct computer use had a negative effect on computer attitudes, when confidence was held constant. Results suggest how computer educational environments are important for confidence building.

| | |
|---|---|
| Number of valid cases | 1416 |
| Missing / Omitted cases | 151 |
| Mean | 28.27 |
| Possible range of scores | 6 to 36 |
| Standard Deviation | 5.073 |

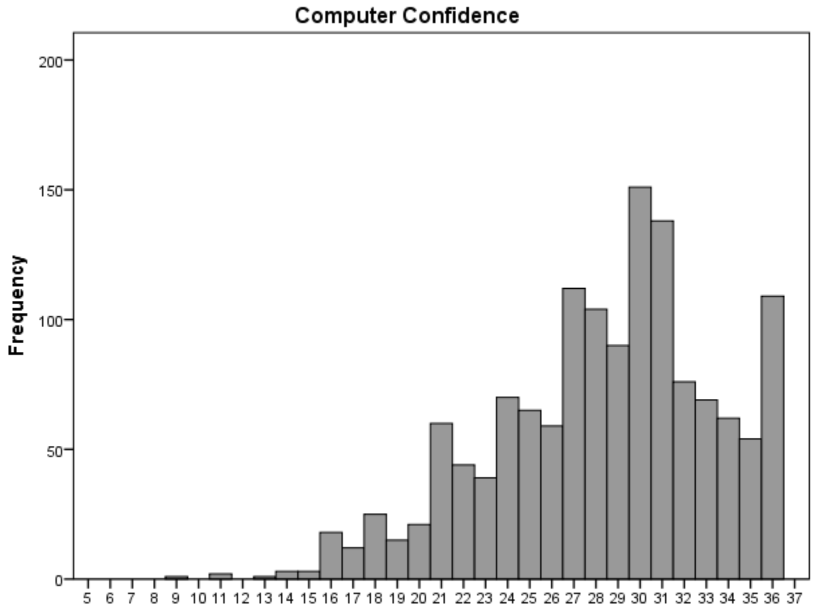


***Figure 5.4. Frequency distribution for responses from all students on the Computer Confidence Scale.***

### *5.5.7 Fluid vs. Fixed Intelligence Scale*

The Fluid versus Fixed Intelligence scale was a pair of items that were added onto the questionnaire to measure if students see intelligence as something fixed (you have a set amount of intelligence and cannot change it) or if it is something fluid (you can become more intelligent with hard work) (for more, see Cattell, 1963).

According to studies, people regard intelligence either as being *fixed*—something that is unchangeable and characteristic—or being *malleable*—something that can be changed. How people view the malleability of intelligence matters a great deal in education. Students who believe intelligence is fixed typically think that needing to expend effort to learn indicates low intelligence. When students with a fixed view of intelligence encounter a concept that they do not immediately and effortlessly understand, they typically believe that they are incapable of mastering it and thus expend less effort to learn according to Dweck (2014). We obviously want the students to feel that intelligence is something that is fluid, and that 'everyone can all learn new things'.

This composite score was made up of the sum for responses to items 20 and 23 (Questions 20 & 23 in Appendix A), ranging from 2 to 12 points so that "Intelligence is more fluid" = 2; "Intelligence is more fixed" = 12.

| | |
|---|---|
| Number of valid cases | 1282 |
| Missing / Omitted cases | 285 |
| Mean | 7.38 |
| Possible range of scores | 2 to 12 |
| Standard Deviation | 2.99 |

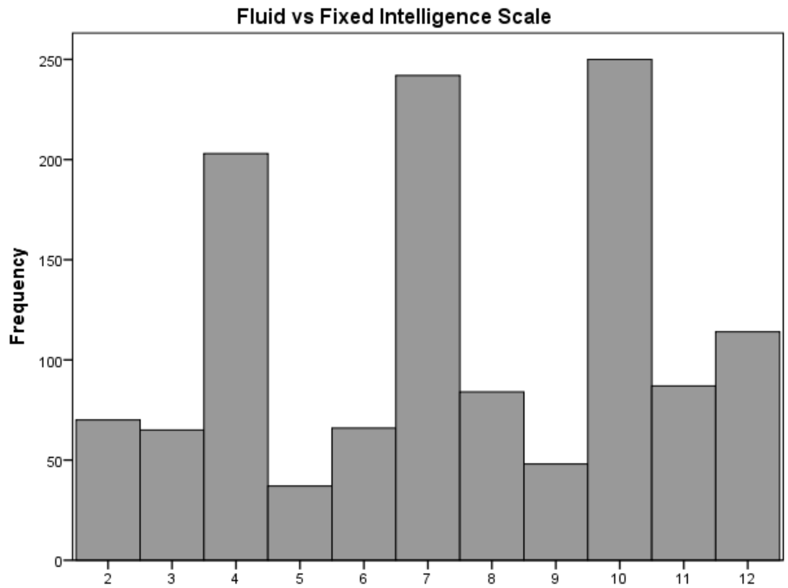


***Figure 5.5. Frequency distribution for responses from all students on the Fluid vs. Fixed Intelligence Scale.***

### *5.5.8 Analysis*

While the Self-Reported Visual Difficulties Scale is useful for informing us about how students perceive their level of impairment, it did not seem practical to perform any statistical analysis between comparison groups on this scale. It was also decided that Fluid vs. Fixed Intelligence Scale would not be analyzed between comparison groups because there seemed to be a lot of confusion from students on what this scale actually pertained to.

The following sections will cover each of the comparison groups (Gender, Integrated/Specialized Schools, Primary/Secondary schools, and Thika schools to other schools). Each statistical comparison will be discussed and the results will be provided.

#### 5.5.8.1 Gender

**Gender**: The first analysis was run to see if male and female students responded with significant differences to any of the scales. Ideally they would be the same, indicating similar feelings between both groups. *No significant differences were found between male and female average responses* for these scales.

*Table 5.6. Averages across scales by Gender*

| | Males | Females | Sig. Difference? |
|---|---|---|---|
| **Perceived Burden** | 5.22 | 5.39 | No |
| **Interest in Training** | 46.08 | 45.70 | No |
| **Computer Confidence** | 28.46 | 28.03 | No |

While not finding a statistically significant difference may not seem very interesting in the data, this is actually a good thing because it means that the male and female students have generally the same outlook on these scales.

#### 5.5.8.2 Integrated Schools vs. Specialized Schools

**Integrated Schools vs. Specialized Schools**: Next we were interested to see if students who are integrated into mainstream classrooms responded differently from those who attend specialized schools for the blind. While we had much smaller sample sizes for the integrated schools than the specialized schools, Levene's Test was run and Equality of Variances was passed (this means that even though there were a much larger number of samples from the specialized schools, the variance rates among responses was still similar). *There were no statistically significant differences* between average response scores for students in the integrated schools compared to those in the specialized schools for the blind.

*Table 5.7. Averages (and sample size) between Integrated and Specialized Schools*

| | Integrated (N) | Specialized (N) | Sig. Difference? |
|---|---|---|---|
| **Perceived Burden** | 5.57 (84) | 5.27 (1497) | No |
| **Interest in Training** | 45.21 (70) | 45.95 (1350) | No |
| **Computer Confidence** | 28.13 (75) | 28.28 (1341) | No |

#### 5.5.8.3 Primary Schools vs. Secondary Schools

**Primary Schools vs. Secondary Schools**: One of our hypotheses was that older students in the secondary schools would show a greater interest in training as well as more computer confidence because they may realize greater value in the program, as they are closer to graduation. There were somewhat large sample size variations with almost twice as many students in primary school compared to secondary school. Thus Levene's Test of Equality of Variances was run, and the response variations for all three composite scores failed this test. Due to this we corrected for equal variances not assumed.

Students in Secondary School had significantly lower mean Perceived Burden scores (4.70) compared to Primary School students (5.55) with $t(1066) = -5.575$, $p < .05$. Secondary school students had a significantly higher mean Interest in Training score (47.87) compared to the primary school students' mean score (45.05), with $t(1062) = 9.772$, $p < .05$. Secondary school students had significantly higher mean Computer Confidence scores (30.20) compared to the primary school students' mean score (27.40), with $t(1180) = 11.198$, $p < .05$.

*Table 5.8. Averages between Secondary and Primary Schools*

| | Secondary Schools | Primary Schools | Sig. Difference? |
|---|---|---|---|
| **Perceived Burden** | 4.70 | 5.55 | Yes |
| **Interest in Training** | 47.87 | 45.05 | Yes |
| **Computer Confidence** | 30.20 | 27.40 | Yes |

#### 5.5.8.4 Thika Schools vs. Other Schools

**Thika Schools vs. Other Schools**: Some of the students at the Thika schools have already participated in some of the computer training, or are at least aware of the program. We hypothesized that this knowledge of computers and associated training courses may lead to a higher 'excitement' or interest in computer training among the Thika students compared to students at the other schools. Like with the other analyses, we could not assume equal variances among the groups due to differences in sample size (Levene's Test failed) so we will be reporting the corrected t-scores. Thika students showed significantly lower mean Perceived Burden scores (4.50) compared to the mean score from other schools (5.64), with $t(1075.7) = -7.562$, $p < .05$. Thika students have a significantly higher mean score for Interest in Training (46.75) compared to mean score from other schools (45.66), with $t(931) = 3.594$, $p < .05$. Thika students showed a significantly greater mean score (29.25) for Computer Confidence as compared to other schools mean score (27.9), $t(975) = 5.017$, $p < .05$.

#### 5.5.8.5 Thika vs. Other BY Primary vs. Secondary

**Thika vs. Other BY Primary vs. Secondary**: Considering the significant main effects of Thika students' mean composite scores, we were interested to see if there may be an interaction between Thika schools and the other schools as moderated by Primary versus Secondary schools. *The results did not show a statistically significant interaction*. However the means for these groups are plotted on the next few graphs. These graphs show the mean scores for Thika schools versus other schools and are separated into secondary and primary schools to aid discussion. Means for Thika are shown for secondary and primary schools connected by a solid line. The mean score for each of the three composite scores from all other (non-Thika) schools are shown by secondary and primary schools connect by a dashed line.

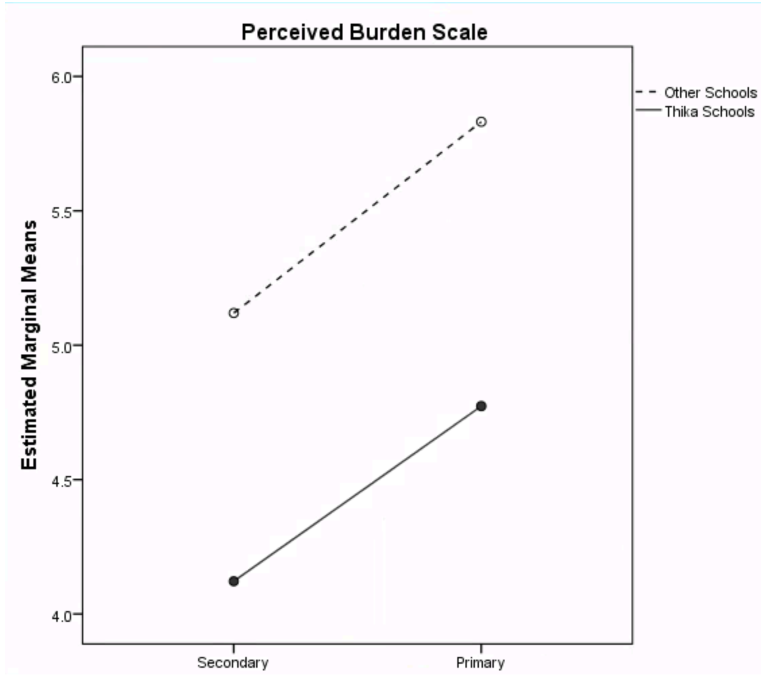


***Figure 5.6. Perceived Burden Scale, for Primary and Secondary students, plotted by Thika versus Other schools.***

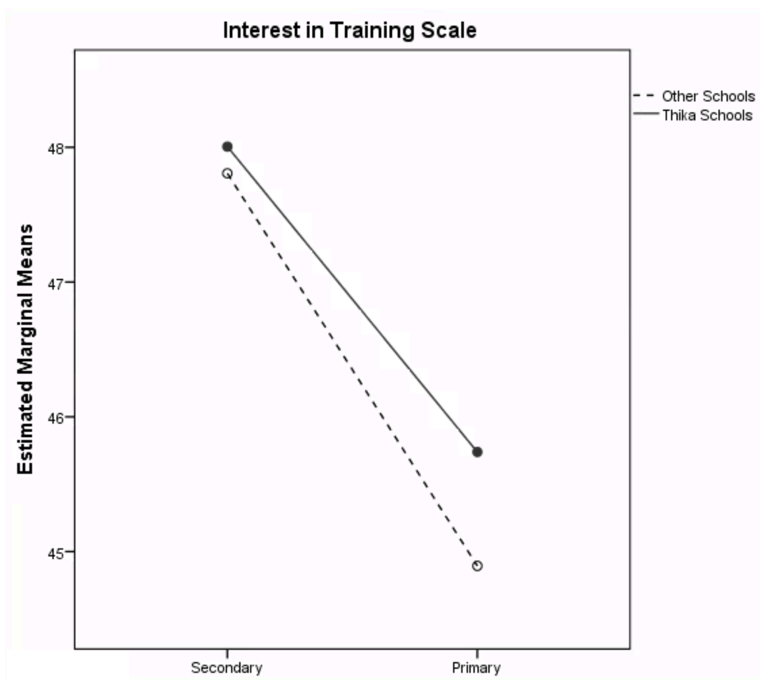


***Figure 5.7. Interest in Training Scale, for Primary and Secondary students, plotted by Thika versus Other schools.***

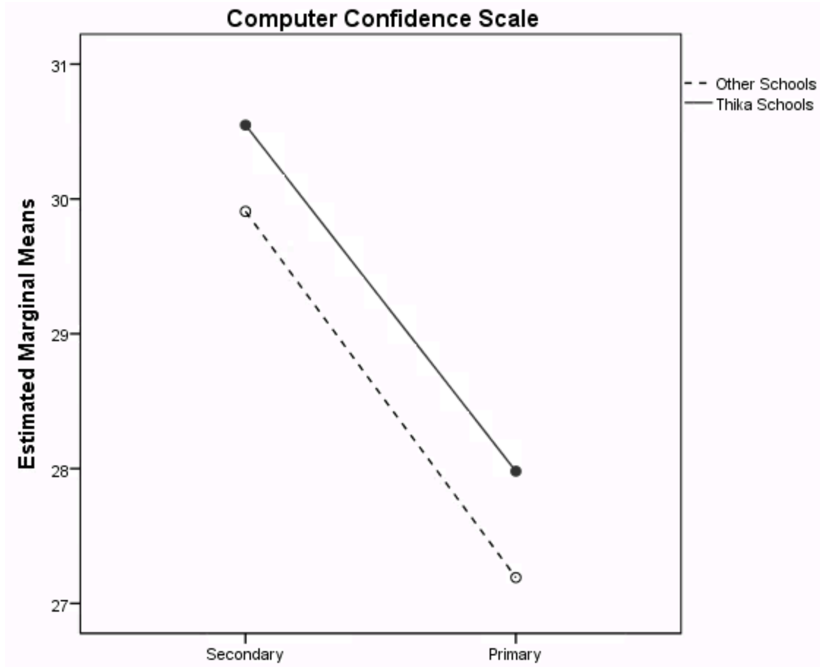


***Figure 5.8. Computer Confidence Scale, for Primary and Secondary students, plotted by Thika versus Other schools.***

### 5.5.8.6 Thika vs. Other BY Gender

**Thika vs. Other BY Gender**: Considering the significant main effects of Thika students' mean composite scores, we were interested to see if there may be an interaction between Thika students and students at other schools, separated by gender. It turned out that there were not statistically reliable differences between the groups, but given the small sample size at this level of analysis, it may still be interesting to view the trends.

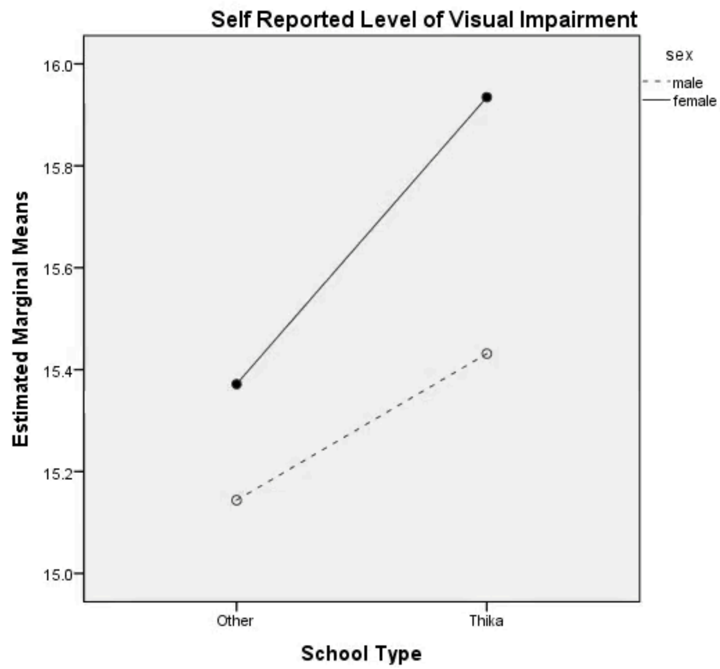


***Figure 5.9. Self Reported Level of Visual Impairment, for Thika versus Other schools, plotted by Male and Female students.***

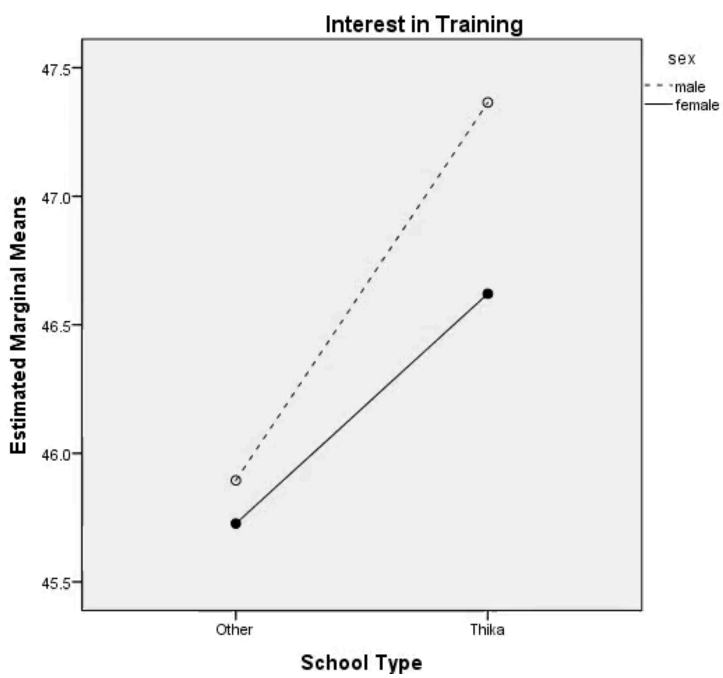


***Figure 5.10. Interest in Training Scale, for Thika versus Other schools, plotted by Male and Female students.***

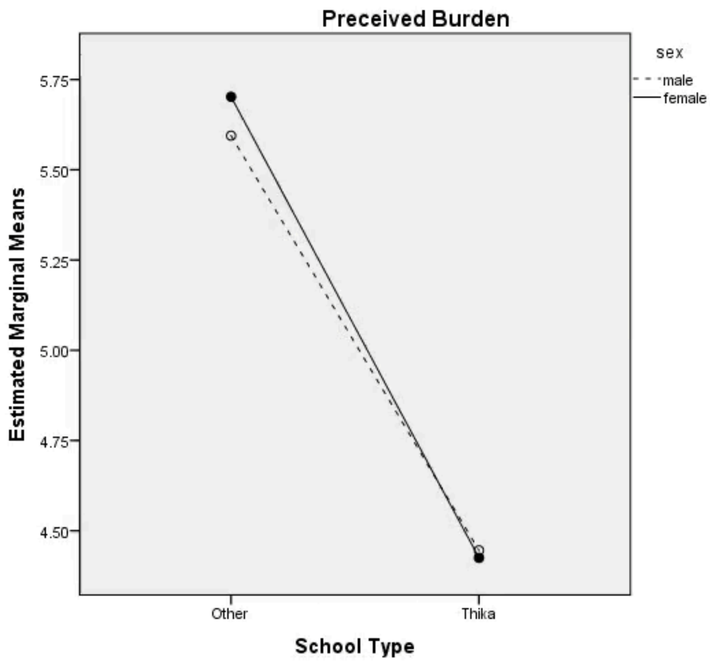


***Figure 5.11. Perceived Burden Scale, for Thika versus Other schools, plotted by Male and Female students.***

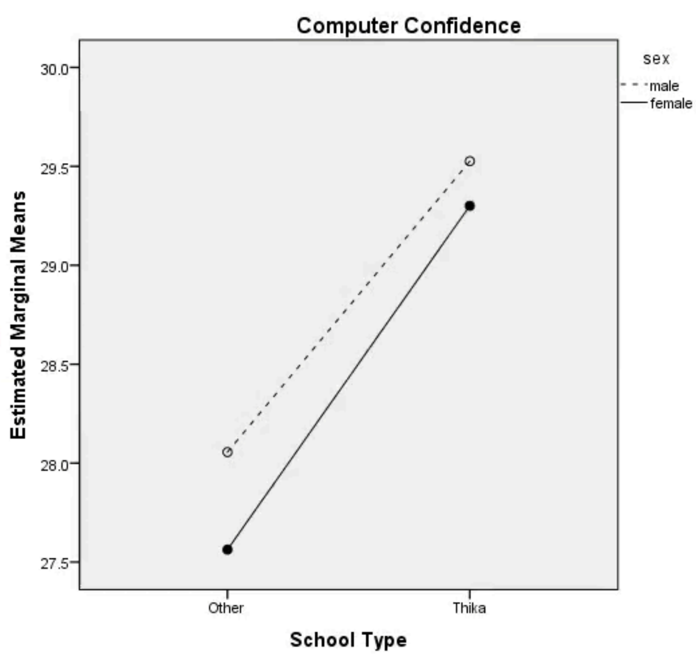


***Figure 5.12. Computer Confidence Scale, for Thika versus Other schools, plotted by Male and Female students.***

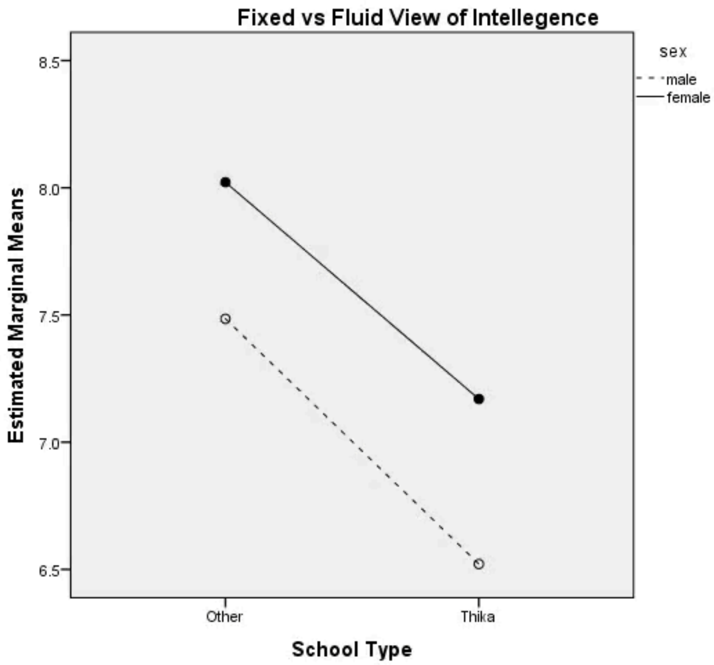


***Figure 5.13. Fixed vs. Fluid Intelligence Scale (reverse coded), for Thika versus Other schools, plotted by Male and Female students. Lower numbers indicate respondents believe intelligence is more fluid.***

## 5.6 Summary of Results for Nationwide Student Survey

The following is a higher-level summary of the analysis.

**GENDER** - There was no significant difference between response averages for boys and girls. They showed equal amounts of interest and confidence in wanting to learn about computers (no sig. difference on *Perceived Burden*, *Interest in Training*, and *Computer Confidence* scales)

**PRIMARY vs. SECONDARY** – the older students had higher average scores (statistically sig) for both the *Interest in Training* and *Computer Confidence* scales, as well as a lower average score for *Perceived Burden*.

**THIKA vs. OTHER** - We did see a statistically larger difference in response average scores for Thika students on *Interest in Training* and *Computer Confidence*, plus a lower average for *Perceived Burden* compared to the other schools.

**THIKA vs. OTHER by PRIMARY vs. SECONDARY** – Results were not statistically significant but plotting the means showed some trends that may be interesting to examine in subsequent studies.

- Perceived Burden was lower overall for students at Thika versus other schools.
- Interest in Training seemed to be marginally higher for students in Primary school who were at Thika, but went up for all schools at the Secondary school level.

- Computer Confidence was higher for students at Thika (Primary & Secondary)

**GENDER by THIKA** – While the difference in averages scores are *not* statistically significant, we can see trends when plotted.

In general, it seems that students at schools where the inABLE computer training program has been initiated show the expected higher levels of interest in training and self-perceived computer skills. What is particularly notable is that the students at the Thika schools also report higher ratings on the psychosocial measures, which one may consider as very possibly related to the different experience and training those students have, vis-a-vis information technology.

# 6 Supplemental Survey of Undergraduates With Vision Loss at Kenyatta University (2016)

## 6.1 Overview

The initial baseline survey (see Section 5, above) was completed with students who are in primary or secondary schools in Kenya. Some students who are blind or have low vision do graduate from secondary school, and do go on to university, where they likely use technology more, and seem more likely to have favorable views about the importance of technology. We also surmised that these older, more academically advanced students would also have more independence and higher feelings of self worth. To examine the opinions of those older students, we collected a sample of blind and low vision students at Kenyatta University. The procedure and data collection were the same as for the larger study (see Section 5, above; and Appendix B for the near-identical questionnaire). The results are presented below.

## 6.2 Participants

There were a total of 32 students from Kenyatta University who took part in this survey. Students' average age was 25.6 years old, with a standard deviation of 5.56. Ages ranged from 20 to 44.

## 6.3 Results

All data were analyzed using IBM's Statistical Package for Social Sciences (SPSS) software. Responses from all students who participated were anonymized and compiled into a master response list.

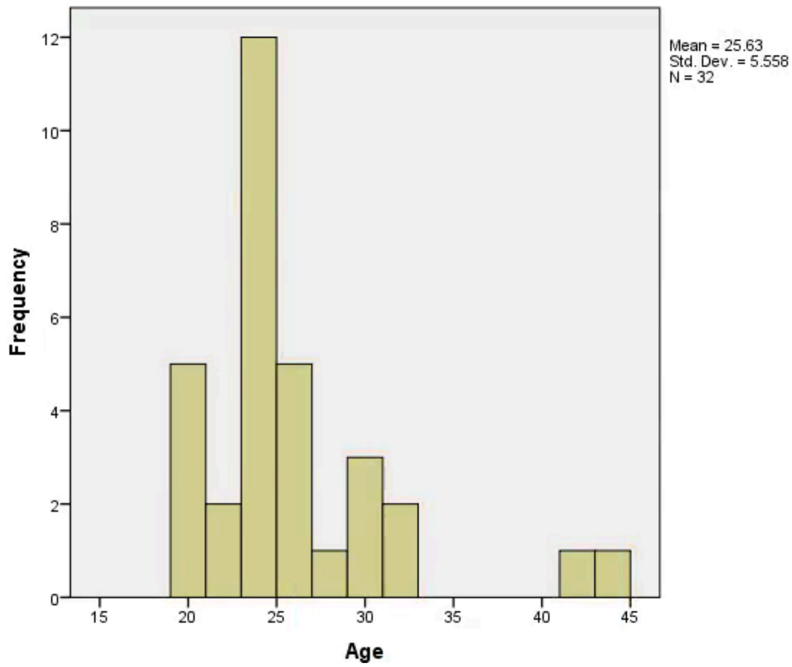


***Figure 6.1. Frequency histogram of Age of students in the supplemental survey of undergraduate students.***

***Table 6.1: Number of Kenyatta University (KU) Student Participants by Gender***

| | **Frequency** | **Percent** |
|---|---|---|
| Male | 21 | 65.6 |
| Female | 11 | 34.4 |
| **TOTAL** | **32** | **100 %** |

When asked about computer use, 53.1% of students responded that they use a computer every day (see Table 6.2). All students responded to using a computer at least a few times or more.

***Table 6.2: Number of KU Students by self-reported Computer Usage group***

| | **Frequency** | **Percent** |
|---|---|---|
| Never | 0 | 0 |
| Once | 0 | 0 |
| A few times | 6 | 18.8 |
| Weekly | 9 | 28.1 |
| Every day | 17 | 53.1 |
| **TOTAL** | **32** | **100 %** |

### *6.3.1 Composite Scores*

To look for trends in students' responses, a series of composite scores were created. These scores were created out of categories from the items on the questionnaire. Individual scores from each item within the composite groups were added together for the composite score. We took this approach to make it easier for group comparisons and looking for overall trends.

### 6.3.2 Self-Reported Visual Difficulties Scale

We did not want to directly ask the students about their level of visual impairment, mainly because this may have been somewhat difficult for every student to specify. Instead we created a composite score from six of the questionnaire items that ask each student about how much difficulty she or he may experience with various tasks (Questions 1 through 6 in Appendix B). The *Self-Reported Visual Difficulties* score is a sum of questions 1 through 6 on the questionnaire. These are on a 5-point Likert scale, so these scores have a possible range between 6 and 30 in that “No trouble with visual tasks” = 6; “Extreme difficulty with visual tasks” = 30.

| | |
|---|---|
| Number of valid cases | 32 |
| Missing / Omitted cases | 0 |
| Mean | 18.13 |
| Possible range of scores | 6 to 30 |
| Standard Deviation | 4.18 |

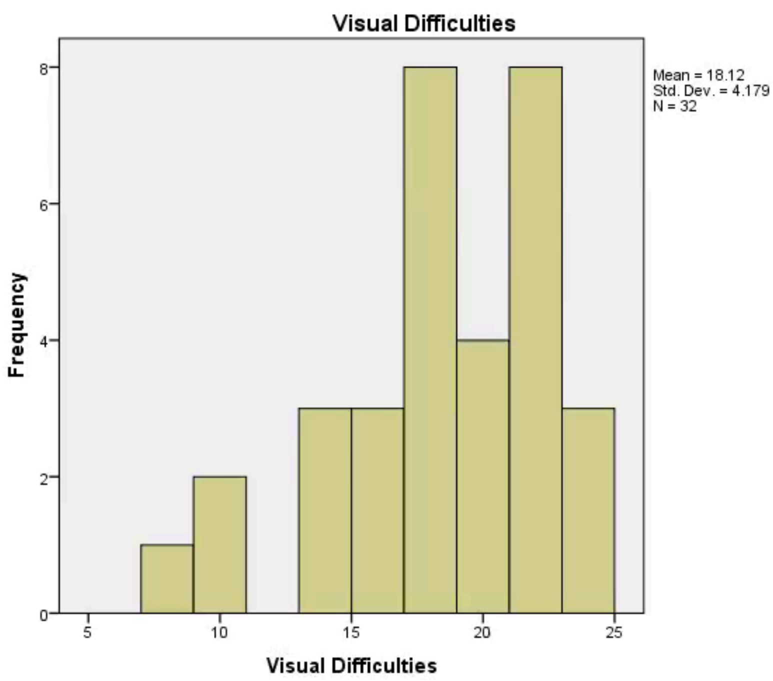


***Figure 6.2. Frequency histogram of Self-Reported Visual Difficulties Scale for students in the supplemental survey of undergraduate students.***

### 6.3.3 Perceived Burden Scale

Two of the questions (Questions 7 & 8 in Appendix A) ask how the students feel about themselves; "I feel ashamed or embarrassed…" and "I often feel that I am a burden on others…". These are both on a 6-point Likert scale from 1 (strongly disagree) to 6 (strongly agree) with the statement. The purpose of these questionnaire items is to establish the level of students' self worth. If these scores started out high we would hope they lower over time, and if they stared low we will look to keep them low. This all would indicate that students would tend to see themselves as less of a burden to others as they become more proficient at using computers. The composite score for *Perceived Burden* is on a scale from 2 to 12.

| | |
|---|---|
| Number of valid cases | 32 |
| Missing / Omitted cases | 0 |
| Mean | 4.69 |
| Possible range of scores | 2 to 12 |
| Standard Deviation | 2.147 |

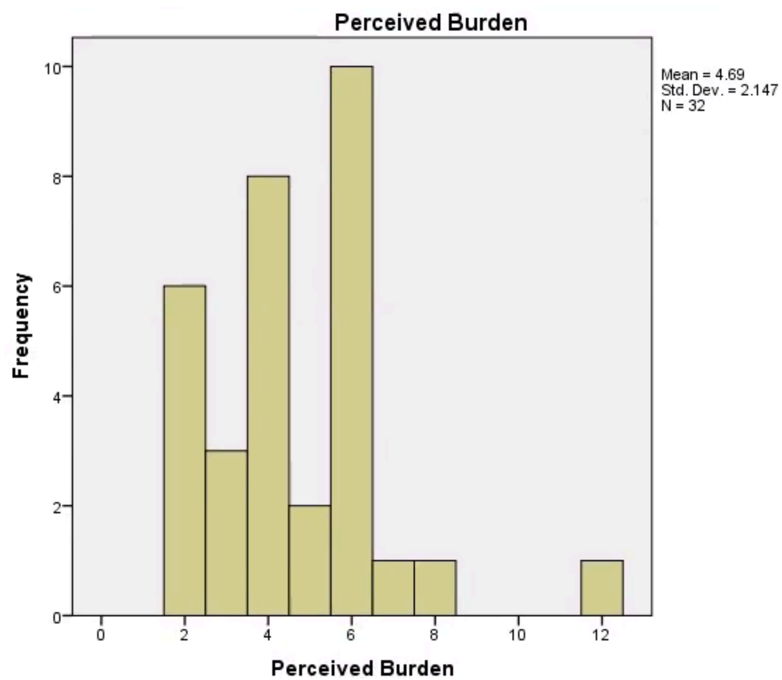


***Figure 6.3. Frequency histogram of Perceived Burden Scale for students in the supplemental survey of undergraduate students.***

### 6.3.4 Interest in Training Scale

This composite score was created by a sum of all the item responses for questions that asked students about how important or useful they think it would be to learn about computers. There were 10 items total (Questions 9, 10, 11, 17, 18, 19, 24, 25, 26 and 28 in Appendix A). Some of the questions were negatively worded, so these questions were reversed scored (questions 10, 17, and 19). Responses for the *Interest in Training* score ranged from 10 at the lowest to 60 being the highest amount of interest.

| | |
|---|---|
| Number of valid cases | 32 |
| Missing / Omitted cases | 0 |
| Mean | 54 |
| Possible range of scores | 10 to 60 |
| Standard Deviation | 3.483 |

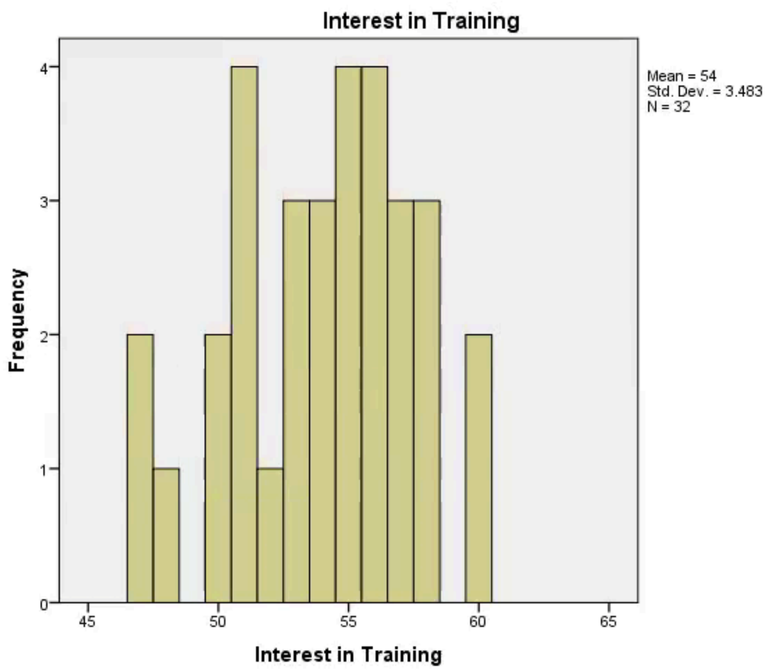


***Figure 6.4. Frequency histogram of Interest in Training Scale for students in the supplemental survey of undergraduate students.***

### *6.3.5 Computer Confidence Scale*

This composite score was created from the sum of the 7 items that ask about how much confidence the students have in their own ability to learn to use a computer (Questions 12, 13, 14, 15, 16, 22, and 28 in Appendix A). Some of these were negatively worded so they were reverse scored before creating the composite (questions 12, 14, 16, and 22 were reversed). *Computer Confidence* score ranged from 7 at the lowest to 42 as the highest amount of confidence.

| | |
|---|---|
| Number of valid cases | 31 |
| Missing / Omitted cases | 1 |
| Mean | 31.58 |
| Possible range of scores | 7 to 42 |
| Standard Deviation | 5.378 |

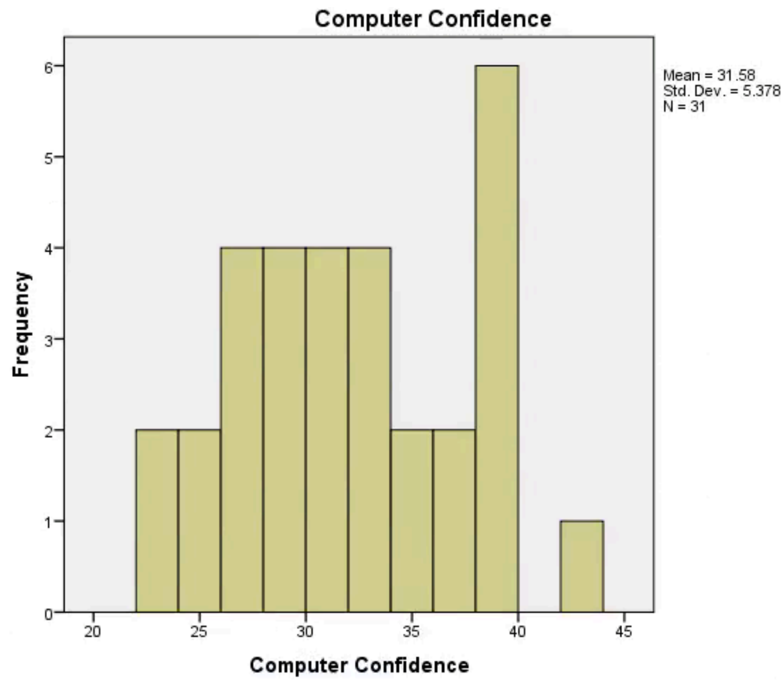


***Figure 6.5. Frequency histogram of Computer Confidence Scale for students in the supplemental survey of undergraduate students.***

### *6.3.6 Fluid vs. Fixed Intelligence Scale*

The Fluid versus Fixed Intelligence scale was a pair of items that were added onto the questionnaire to measure if students see intelligence as something fixed (you have a set amount of intelligence and cannot change it) or if it is something fluid (you can become more intelligent with hard work). We obviously want the students to feel that intelligence is something fluid and that 'everyone can all learn new things'. This composite score was made up of the sum for responses to items 20 and 23 (Questions 20 & 23 in Appendix A), ranging from 2 to 12 points so that "Intelligence is more fluid" = 2; "Intelligence is more fixed" = 12.

| | |
|---|---|
| Number of valid cases | 27 |
| Missing / Omitted cases | 5 |
| Mean | 5.19 |
| Possible range of scores | 2 to 12 |
| Standard Deviation | 2.69 |

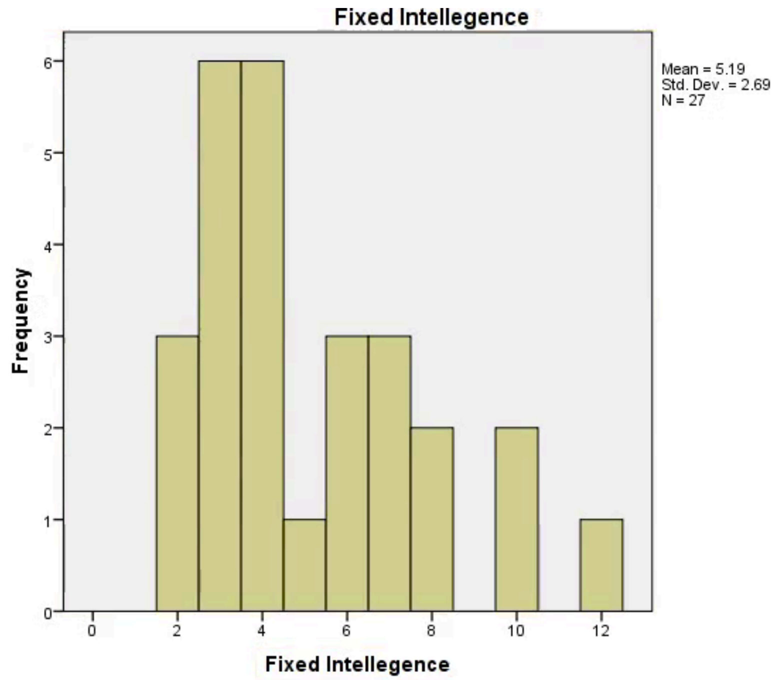


***Figure 6.6. Frequency histogram of Fixed versus Fluid Intelligence Scale for students in the supplemental survey of undergraduate students.***

## 6.4 Summary of Results from Undergraduates With Vision Loss at KU

The undergraduate students at Kenyatta University show similar distributions of responses as the students at the younger ages. The undergraduates generally report slightly better scores on functional vision (less impairment) than the younger students, which is not surprising since the younger sample includes many blind students whereas the students who reach university are much more likely to have some vision (though certainly not all do). Further, the older students continue the trends seen in the primary versus secondary schools, in that the undergraduates show lower perceived burden. They also report more computer usage, higher perceived skills (which is likely accurate, given their more frequent usage), and overall greater interest in technology skills training.

# 7 Supplemental Nationwide Survey of Teachers of Blind and Low-Vision Learners

## 7.1 Overview

In addition to the baseline survey with blind and low-vision school students, and the supplemental survey of undergraduate blind students at Kenyatta University, it is crucial to consider the perspectives of teachers who interact with all of these types of students. There are questions of whether the teachers have technology experience and computer training, themselves, and whether they have interest in gaining more training. In this regard, the teachers can be asked questions that are very similar to the questions asked of the students. In addition, it is important to understand how the teachers feel about the students. That is, it is critical to know whether the teachers believe what students are capable of, and whether technology is useful to the students in achieving their life and career goals. We collected both kinds of information, using a combination of questionnaires and interviews/focus groups.

A (second) nationwide survey of computer experience and adoption attitudes was successfully mounted during the month of February (23rd to 25th), 2016, this time focusing on the teachers rather than the students. The survey was carried out in all the schools for the blind across Kenya as well as some integrated schools with low vision students. Data were collected through questionnaires and followed up in some cases with focus group discussions. All teachers in the schools for the blind participated in the survey. Focus groups were carried out with all the teachers who participated in the study to gain clarification and details of responses on the questionnaire. Staff selected from four interdependent research groups (Kenyatta University, Ministry of Education special needs department, inAble, and Infotrak), formed the 33 data collection teams that visited the various schools.

As required, all data collectors were certified HRS on CITI through affiliation to Georgia Tech. Infotrak supplied tablets and technical support during data collection. The tablets used the same Computer Assisted Personal Interviewing (CAPI) software and method to ensure that authenticated data was collected in real time. Graduate students from Georgia Tech and from Kenyatta University who were attached to the project were involved in the data analysis process.

As before, questionnaire data were analyzed using IBM's Statistical Package for Social Sciences (SPSS) software. Responses from all teachers who participated were anonymized and compiled into a master response list. Other qualitative data (e.g., from focus groups) were summarized, and assessed for themes and commonalities, however those supplemental data are not detailed in this report.

## 7.2 Results From Kenya Teachers Survey 2016

There were a total of 203 teachers surveyed across 12 schools in Kenya.

***Table 7.1: Number of Teacher Participants at Each School***

| School | Frequency | Percent |
|---|---|---|
| Thika Primary School for the Blind | 22 | 10.8 |
| Thika High School for the Blind | 28 | 13.8 |
| St. Lucy's Primary School for the Blind | 18 | 8.9 |
| St. Lucy's High School for the Blind | 16 | 7.9 |
| St. Oda Primary School for the Blind | 19 | 9.4 |
| Nico Hausa High School for the Blind | 15 | 7.4 |
| Kibos Primary for the Blind | 13 | 6.4 |
| Kibos High School for the Blind | 15 | 7.4 |
| Likoni Primary and High Schools for the Blind | 21 | 10.3 |
| St. Francis Primary School for the Blind | 17 | 8.4 |
| St. Francis High School for the Blind | 12 | 5.9 |
| Kilimani Integrated Primary School | 7 | 3.4 |
| **TOTAL** | **203** | **100 %** |

### *7.2.1 Demographic Profile of Teacher Participants*

***Table 7.2. Age of Teacher Participants***

The average age of teachers was 39.7 years old, ranging from 21 to 65 years old. There were a total of 98 male and 105 female participants.

***Table 7.3. Self-Described Visual Ability***

| | Frequency | Percent |
|---|---|---|
| Sighted | 126 | 62.1 |
| Low Vision | 35 | 17.2 |
| Blind | 42 | 20.7 |
| **TOTAL** | **203** | **100 %** |

***Table 7.4. Computer Usage Regularity***

| | Frequency | Percent |
|---|---|---|
| I have never used a computer | 17 | 8.4 |
| I used one once | 19 | 9.4 |
| I use one a few times | 40 | 19.7 |
| I use one weekly | 44 | 21.7 |
| I use one every day | 83 | 40.9 |
| **TOTAL** | **203** | **100 %** |

### *Table 7.5. Internet Usage Regularity*

| | Frequency | Percent |
|---|---|---|
| I have never used the internet | 23 | 11.3 |
| I used it once | 14 | 6.9 |
| I have used it a few times | 26 | 12.8 |
| I use it weekly | 19 | 9.4 |
| I use it every day | 121 | 59.6 |
| **TOTAL** | **203** | **100 %** |

### *Table 7.6. Home Internet*

| | Frequency | Percent |
|---|---|---|
| Yes | 111 | 54.7 |
| No | 92 | 45.3 |
| **TOTAL** | **203** | **100 %** |

### *Table 7.6. Internet Connected Smart Phone*

| | Frequency | Percent |
|---|---|---|
| Yes | 165 | 81.3 |
| No | 38 | 18.7 |
| **TOTAL** | **203** | **100 %** |

### *Table 7.7. Current Mobile Operating System*

| | Frequency | Percent |
|---|---|---|
| I do not know/ remember | 15 | 7.4 |
| Android | 111 | 54.7 |
| iPhone (iOS) | 5 | 2.5 |
| Windows Phone | 17 | 8.4 |
| Symbian | 15 | 7.4 |
| Blackberry | 1 | 0.5 |
| Motorola | 1 | 0.5 |
| No Response | 38 | 18.7 |
| **TOTAL** | **203** | **100 %** |

### *Table 7.8. Primary Subject Taught*

| **Subject** | **Frequency** | **Percent** |
|---|---|---|
| Science (Biology, Chemistry, Physics) | 71 | 35 |
| Mathematics | 30 | 14.8 |
| Language (Kiswahili, English, French) | 68 | 33.5 |
| Social Studies (Georg, History, CRE) | 24 | 11.8 |
| Computer Science/IT | 1 | .5 |
| Other | 9 | 4.4 |
| **TOTAL** | **203** | **100 %** |

*Table 7.9. Secondary Subject Taught*

| Subject | Frequency | Percent |
|---|---|---|
| Science (Biology, Chemistry, Physics) | 0 | 0 |
| Mathematics | 38 | 18.7 |
| Language (Kiswahili, English, French) | 25 | 12.3 |
| Social Studies (Georg, History, CRE) | 47 | 23.2 |
| Computer Science/IT | 0 | 0 |
| Other | 12 | 5.9 |
| None | 81 | 39.9 |
| **TOTAL** | **203** | **100 %** |

*Table 7.10. Third Subject Taught*

| Subject | Frequency | Percent |
|---|---|---|
| Science (Biology, Chemistry, Physics) | 0 | 0 |
| Mathematics | 0 | 0 |
| Language (Kiswahili, English, French) | 8 | 3.9 |
| Social Studies (Georg, History, CRE) | 15 | 7.4 |
| Computer Science/IT | 0 | 0 |
| Other | 2 | 1 |
| None | 178 | 87.7 |
| **TOTAL** | **203** | **100 %** |

*Table 7.11. Other Subjects Taught (presented in categories)*

| | Frequency |
|---|---|
| Agriculture | 2 |
| Braille | 4 |
| Life Skills | 4 |
| Orientation Mobility | 1 |
| Home Sciences | 4 |
| Business Studies | 4 |
| Creative Arts | 2 |
| Music and Movements | 3 |
| Mobility | 2 |
| Physical Education | 2 |
| PPI | 2 |
| Special Needs | 1 |

*Table 7.12. How long have you taught in this school?*

| | Frequency | Percent |
|---|---|---|
| Less than 1 Year | 46 | 22.7 |
| 3 to 5 Years | 54 | 26.6 |
| 6 to 10 Years | 44 | 21.7 |
| Over 10 Years | 59 | 29.1 |
| **TOTAL** | **203** | **100 %** |

### *7.2.2 Composite Scores*

To look for trends in teachers' responses, a series of composite scores were created. These scores were created out of categories from the items on the questionnaire. Individual scores from each item within the composite groups were added together for the composite score. We took this approach to make it easier for group comparisons and looking for overall trends.

#### 7.2.2.1 Interest in Training Scale

This composite score was created by a sum of all the item responses for questions that asked students about how important or useful they think it would be to learn about computers. There were 12 items total (Questions 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, and 23 in Appendix A). Some of the questions were negatively worded, so these questions were reversed scored (questions 10, 12, 14, 16, 17, and 19). Responses for the *Interest in Training* score ranged from 10 at the lowest to 72 being the highest amount of interest.

| | |
|---|---|
| Number of valid cases | 200 |
| Missing / Omitted cases | 3 |
| Mean | 61.36 |
| Possible range of scores | 12 to 72 |
| Standard Deviation | 5.07 |

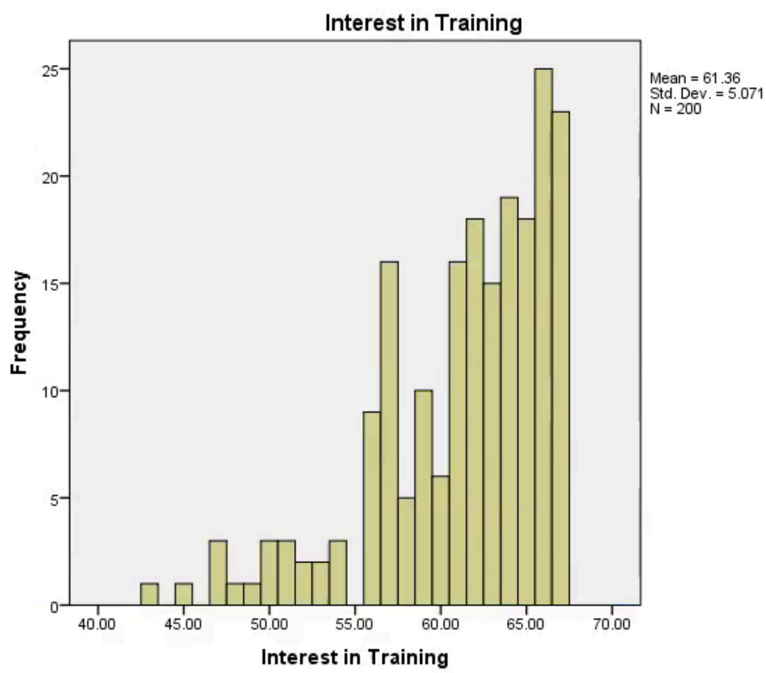


***Figure 7.1. Frequency histogram of Interest in Training Scale for teachers in the supplemental survey of teachers who work with blind and low-vision students.***

#### 7.2.2.2 Computer Confidence Scale

This composite score was created from the sum of the 5 items that ask about how much confidence the teachers have in their own ability to learn to use a computer (Questions 7, 8, 9, 20, and 21 in Appendix A). Some of these were negatively worded so they were reverse scored before creating the composite (questions 8, 9, and 21 were reversed). *Computer Confidence* score ranged from 5 at the lowest to 30 as the highest amount of confidence.

| | |
|---|---|
| Number of valid cases | 201 |
| Missing / Omitted cases | 2 |
| Mean | 23.45 |
| Possible range of scores | 5 to 30 |
| Standard Deviation | 3.81 |

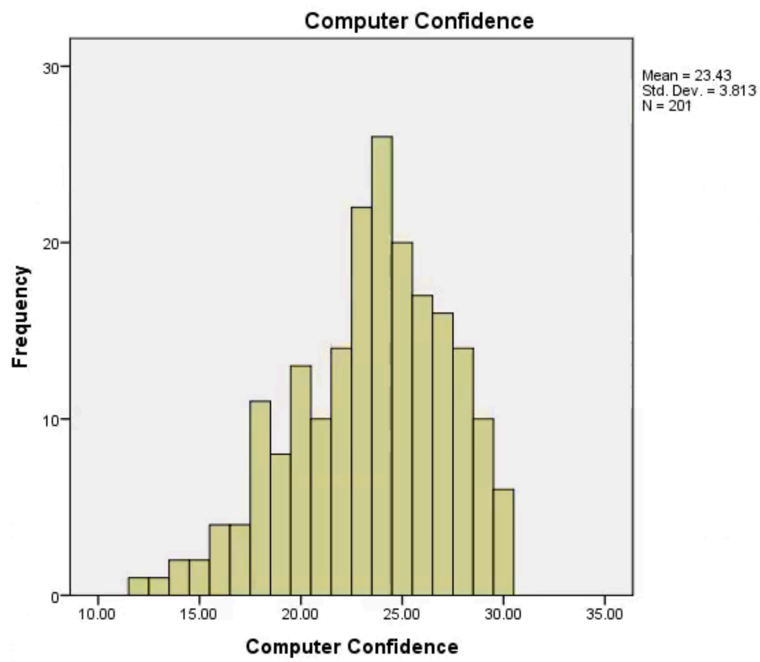


***Figure 7.2. Frequency histogram of Computer Confidence Scale for teachers in the supplemental survey of teachers who work with blind and low-vision students.***

### *7.2.3 Between Group Comparisons*

#### 7.2.3.1 Level of Visual Impairment

When comparing the Computer Confidence and Interest in Training scores between teachers who self reported as sighted, low vision, or blind there was a statistically significant difference between sighted and blind teachers confidence levels [$F(2, 198) = 8.9$, $p< .05$] with blind teachers' *Computer Confidence* scores being lower. There was no significant difference between vision and *Interest in Training*.

*Table 7.13. Mean composite scores for all three self reported vision levels*

| | Computer Confidence | Interest in Training |
|---|---|---|
| Blind | 21.48 | 61.21 |
| Low Vision | 23.03 | 61.60 |
| Sighted | 24.20 | 61.33 |

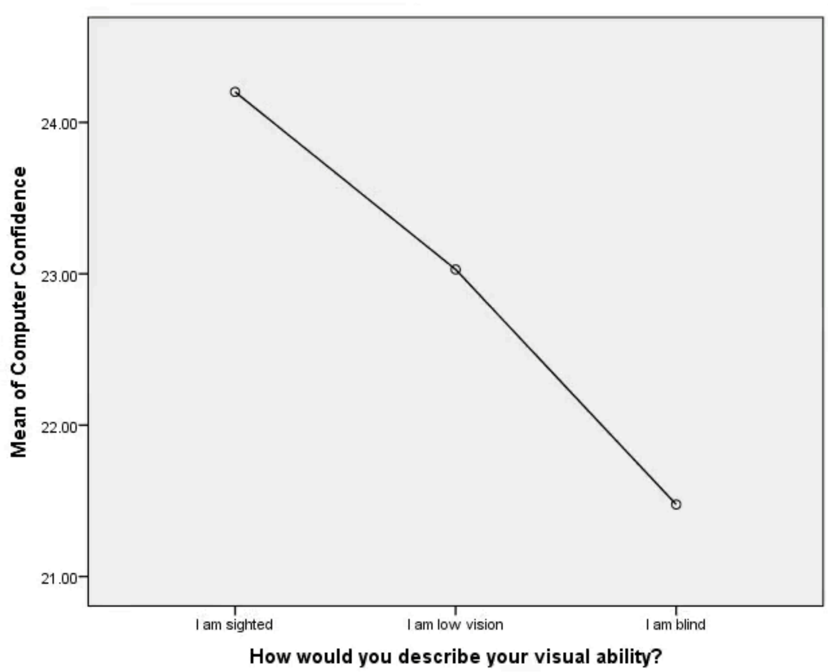


***Figure 7.3. Levels of Self Reported Visual Difficulties for teachers in the supplemental survey of teachers who work with blind and low-vision students. This pattern is statistically reliable (see text for details).***

#### 7.2.3.2 Home Computer

There was no significant difference of mean scores between teachers that had home computers and those who did not.

#### 7.2.3.3 Smart Phone Ownership

There was no significant difference of mean scores between teachers that had smart phones and those who did not.

## 7.3 Focus Group With Teachers (and Summary Results)

### *7.3.1 Overview of Focus Group*

Focus group discussions served to follow up on teachers' questionnaire responses, to further assess their perspectives and readiness to integrate assistive technology in their lessons (see sections above, in this report). The Focus Group Discussions (FGD) targeted both sighted and visually impaired teachers who taught science and mathematics in both primary and secondary sections of the schools. It is important to note that in primary schools, science and mathematics teachers also teach social studies. Although the focus was for STEM education, these teachers provided a general impression of integration of technology for other subjects as well.

The aim of this FGD was to gather detailed information about teachers' training needs in relation to using assistive technology initiative for the special needs learners, the feasibility of the proposed integration of newly invented Assistive Technology for the blind software programs (specifically, the example of accessible weather apps), and expected accessible weather portal and the accessible fantasy soccer in teaching and learning STEM subjects for VI students. A more complete description of the themes and discussions is available in the complete Final Report of the Mwangaza Project.

## 7.4 Summary of Results from Teacher Survey and Focus Group

The teachers have a broad range of computer experience and interest in training. It is notable that nearly 40% of teachers reported using a computer ***never, rarely, or only a few times***. There is very little availability of technology resources, and the teachers are often not allowed to use them, even when they exist. What's more, the teachers do not have the skills to effectively use any computers, even if they were available.

The teachers do, however, see the value in learning technology skills, and in using technology (and assistive technology) to help teach blind and low vision learners. However, there exists considerable mistrust in how technology gets deployed, and they remain insistent that training and support, including curriculum changes, are central to the successful use of these technology tools in schools. In some cases, most notably in schools where the inABLE program has been in place, teachers do have positive opinions about technology. Moreover, they express solutions-oriented suggestions that could increase technology usage.

# 8 Overall Discussion and Conclusions

The Mwangaza Project is an amazing blend of education research, technology, training, and accessibility, rolled together with the deployment of both computer labs and training, and with the support of major research universities, corporations, and the government's education department. This effort is intended to be a truly transformative project, on an international scale. The project addresses individual needs for learners with vision loss, while at the same time increasing learning opportunities in STEM education.

This project is founded on solid research, starting with a nationwide survey of blind and low vision learners and their teachers. The large data set we have collected is instructive in and of itself, in relation to needs and preferences of this educational cohort in Kenya. There are many additional analyses that could be conducted, and research question addressed, using the current data set. We encourage follow-on data mining! But more importantly, the data serve as a baseline against which to evaluate any future programs, both in terms of the goals of a program, as well as the effectiveness of the effort. Already we are seeing evidence that computer skills training (i.e., at Thika) is having important impact not only on skills and computer confidence, but also in terms of the psychosocial well-being of the students who have received training.

The teachers have made it clear how much they also value computing skills, but additionally expressed their opinions regarding training, support, and careful deployment. These are issues that must be carefully considered in any technology deployment effort, and of course have been hallmarks of the inABLE program since its inception.

***"STEM education for blind and low vision students the world over, and similarly in Kenya, has been held hostage to a combination of fear, doubt, lack of knowledge, lack of teacher training skills and resources. These views over time have found a way of being institutionalized as part of education systems. This in turn has had significant negative impacts on lives and career choices of blind and low vision persons as evident by minimal participation in these courses by these learners, particularly at university levels. We aim to make positive stride towards changing that.***

Finally, providing computing resources (labs), and training students and teachers in their use, is only the first (albeit crucial) part of any technology evolution. The real value comes when those technology resources can be used effectively to enhance the general education of students in Kenya, especially in the STEM subjects that have traditionally proved most challenging for blind and low vision students. Deploying software tools that already exist, and developing (and evaluating) new software tools to supplement, is the next step in leveraging technology. We look forward to continuing the process of deploying such tools, and working closely with teachers (and education officials in the Kenyan government) to develop teaching modules and strategies to make effective use of the tools in their classes.

*STEM education for blind and low vision students the world over, and similarly in Kenya, has been held hostage to a combination of fear, doubt, lack of knowledge, lack of teacher training skills and* ***resources****. These views over time have found a way of being institutionalized as part of education systems. This in turn has had significant negative impacts on lives and* *career choices of blind and low vision persons as evident by minimal participation in these courses by these learners, particularly at university levels. We aim to make positive stride towards changing that.*

This results reported in this project are just the beginning, really. There remains so much more to do, but we move forward from the solid foundations of research and evidence-based design laid thus far.

## 9 References Cited


Cattell, R. B. (1963). Theory of fluid and crystallized intelligence: A critical experiment. *Journal of Educational Psychology*, Vol 54(1), Feb 1963, 1-22. http://dx.doi.org/10.1037/h0046743

Chew, Y. C., Davison, B., & Walker, B. N. (2014). From Design to Deployment: An Auditory Graphing Software for Math Education. *Proceedings of the 29th Annual International Technology & Persons With Disabilities Conference (CSUN2014)*, San Diego (17-22 March). pp TBD.

Chew, Y. C., Tomlinson, B. J., Walker, B. N. (2014). *Graph and Number line Input and Exploration (GNIE) Tool Technical Report*. Georgia Institute of Technology School of Psychology Technical Report. May 29, 2014.

Davison, B. K., Suh, H., & Walker, B. N. (2012). Math GNIE: Visually impaired students creating graphs and number lines on a computer. *Proceedings of the AER2012 Conference*. Bellevue, WA (18-22 July).

Davison, B., & Walker, B. N. (2007). Sonification Sandbox overhaul: Software standard for auditory graphs. In Scavone, G. P., *Proceedings of the International Conference on Auditory Display (ICAD 2007)*, Montreal, Canada: ICAD (26-29 June). pp. 509-512.

Dweck, C. S., Walton, G. M., & Cohen, G. L. (2014). Academic Tenacity Mindsets and Skills that Promote Long-Term Learning. Bill and Melinda Gates Foundation: Retrieved from https://ed.stanford.edu/sites/default/files/manual/dweck-walton-cohen-2014.pdf on 10/10.2016

Levine, T., & Donitsa-Schmidt, S. (1998). Computer use, self-confidence, and attitudes: A causal analysis, Computers in Human Behavior, Volume 14, Issue 1, January 1998, pp 125–146.

Tomlinson, B. J., Batterman, J., Chew, Y. C., Henry, A., & Walker, B. N. (2016). Exploring Auditory Graphing Software in the Classroom: The Effect of Auditory Graphs on the Classroom Environment. *ACM Transactions on Accessible Computing (TACCESS)*, *9*(1), 3.

Walker, B. N., & Cothran, J. T. (2003). Sonification Sandbox: A graphical toolkit for auditory graphs. In Brazil, E. & Shinn-Cunningham, B., *Proceedings of the Ninth International Conference on Auditory Display ICAD2003*, Boston, MA (6-9 July) pp 161-163. Boston, MA: Boston University Publications.

Walker, B. N., & Lowey, M. (2004). Sonification Sandbox: A graphical toolkit for auditory graphs. *Proceedings of the Rehabilitation Engineering & Assistive Technology Society of America (RESNA) 27th International Conference*. Orlando, FL., 20-22 June.

# 10 Appendices

(This page intentionally left blank. Appendices start on the next page.)

**APPENDIX A – Questionnaire Items**

***For the first questions, I will ask you how hard it is for you to do some activities. I will read the question and five levels of how difficult it is, and you will tell me which one best fits how you feel about it. The answers are: a not at all difficult, a little bit difficult, somewhat difficult, very difficult, or extremely difficult.***

1. **How hard is it for you to notice things in your way like animals, bushes, or vehicles while you are walking alone?**

Not at all difficult (1)
A little difficult (2)
Somewhat difficult (3)
Very difficult (4)
Extremely difficult (5)

2. **How much does shine from bright lights bother you?**
   Does not bother me at all (1)

Bothers me a little (2)
Bothers me somewhat (3)
Very Bothersome (4)
Extremely bothersome (5)

3. **How difficult is it for you to tell the difference between colors?**

Not at all difficult (1)
A little difficult (2)
Somewhat difficult (3)
Very difficult (4)
Extremely difficult (5)

4. **How difficult is it for you to see when you go into a room after being in bright sunlight?**

Not at all difficult (1)
A little difficult (2)
Somewhat difficult (3)
Very difficult (4)
Extremely difficult (5)

5. **How difficult is it for you to write, read, or do things at normal distance or on the blackboard?**

Not at all difficult (1)
A little difficult (2)
Somewhat difficult (3)
Very difficult (4)
Extremely difficult (5)

6. **How difficult is it for you to do school work because of your eyesight?**

Not at all difficult (1)

A little difficult (2)
Somewhat difficult (3)
Very difficult (4)
Extremely difficult (5)

***In the next section, I am going to ask you how much you agree or disagree with each sentence. I will tell you the sentence and then read out six levels of agreement and disagreement. If you agree with the sentence, it means that you have the same opinion or you think the same way. If you disagree with the sentence, it means that you have a different opinion or that you think in a different way. The levels are strongly disagree, disagree, somewhat disagree, somewhat agree, agree, and strongly agree. You will choose the level that best matches your personal opinion. If you do not understand the sentence, please let me know.***

7. **I feel ashamed or embarrassed because of my eyesight.**
   strongly disagree (1)
   disagree (2)
   somewhat disagree (3)
   somewhat agree (4)
   agree (5)
   strongly agree (6)
   I do not understand this question (0)

8. **I often feel that I am a burden on others because of my eyesight.**
   strongly disagree (1)
   disagree (2)
   somewhat disagree (3)
   somewhat agree (4)
   agree (5)
   strongly agree (6)
   I do not understand this question (0)

9. **I think it is important to learn about computers because they are useful.**
   strongly disagree (1)
   disagree (2)
   somewhat disagree (3)
   somewhat agree (4)
   agree (5)
   strongly agree (6)
   I do not understand this question (0)

10. **I dont think that knowing how to use a computer is important for my future.**
   strongly disagree (1)
   disagree (2)
   somewhat disagree (3)
   somewhat agree (4)
   agree (5)
   strongly agree (6)

I do not understand this question (0)

**11. I think computer training is a good use of my time.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**12. I do not feel confident about my ability to use a computer.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**13. I am the kind of person who will be able to use a computer well.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**14. I am not smart enough to use a computer.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**15. My teachers think that I am the kind of person who can learn to use a computer well.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**16. My eyesight will make it difficult for me to use a computer.**

strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**17. Computers are not important for my daily life.**

strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**18. When I am an adult, I will need to use computers.**

strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**19. I believe that computer training is a waste of time for me.**

strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**20. My intelligence is something about me that I can't change very much.**

strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**21. I believe that someone like me cannot use a computer as well as other people.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**22. My teachers think that I will not be able to use a computer.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**23. I can learn new things, but I can't really change my basic intelligence.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**24. A computer will make it easier for me to do things that are difficult because of my eyesight.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**25. I will be a more independent person if I can use a computer.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

**26. Knowing how to use a computer will make me feel better about myself.**
strongly disagree (1)
disagree (2)
somewhat disagree (3)
somewhat agree (4)
agree (5)
strongly agree (6)
I do not understand this question (0)

***In this next section I will be asking you a few questions that have a set of answers to choose from. Please listen to the question and then pick your answer from the options I read to you:***

**27. How often do you use a computer?**
I have never used a computer (1)
I used one once (2)
I use one a few times (3)
I use one weekly (4)
I use one every day (5)

**28. After completing school, I plan to:**
Go to a university (1)
Go to a middle-level college (2)
Go back home (3)
Get a job (4)
Not Sure (5)
Other (6 + text)

## APPENDIX B.

**Survey Used With Undergraduates at Kenyatta University (nearly identical to survey used for younger students)**

**1)** How hard is it for you to notice things in your way like animals, bushes, or vehicles while you are walking alone?
   a) Not at all difficult (1)
   b) A little difficult (2)
   c) Somewhat difficult (3)
   d) Very difficult (4)
   e) Extremely difficult (5)
   f) I do not understand this question (0)

**2)** How much does shine from bright lights bother you?
   a) Does not bother me at all (1)
   b) Bothers me a little (2)
   c) Bothers me somewhat (3)
   d) Very Bothersome (4)
   e) Extremely bothersome (5)
   f) I do not understand this question (0)

**3)** How difficult is it for you to tell the difference between colors?
   a) Not at all difficult (1)
   b) A little difficult (2)
   c) Somewhat difficult (3)
   d) Very difficult (4)
   e) Extremely difficult (5)
   f) I do not understand this question (0)

**4)** How difficult is it for you to see when you go into a room after being in bright sunlight?
   a) Not at all difficult (1)
   b) A little difficult (2)
   c) Somewhat difficult (3)
   d) Very difficult (4)
   e) Extremely difficult (5)
   f) I do not understand this question (0)

**5)** How difficult is it for you to write, read, or do things at normal distance or on the blackboard?
   a) Not at all difficult (1)
   b) A little difficult (2)
   c) Somewhat difficult (3)
   d) Very difficult (4)
   e) Extremely difficult (5)
   f) I do not understand this question (0)

**6)** How difficult is it for you to do school work because of your eyesight?

a) Not at all difficult (1)
b) A little difficult (2)
c) Somewhat difficult (3)
d) Very difficult (4)
e) Extremely difficult (5)
f) I do not understand this question (0)

**7)** I feel ashamed or embarrassed because of my eyesight.

a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**8)** I often feel that I am a burden on others because of my eyesight.

a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**9)** I think it is important to learn about computers because they are useful.

a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**10)** I don't think that knowing how to use a computer is important for my future.

a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**11)** I think computer training is a good use of my time.

a) strongly disagree (1)

b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**12)** I do not feel confident about my ability to use a computer.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**13)** I am the kind of person who will be able to use a computer well.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**14)** I am not smart enough to use a computer.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**15)** My teachers think that I am the kind of person who can learn to use a computer well.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**16)** My eyesight will make it difficult for me to use a computer.
a) strongly disagree (1)
b) disagree (2)

c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**17)** Computers are not important for my daily life.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**18)** When I am an adult, I will need to use computers.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**19)** I believe that computer training is a waste of time for me.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**20)** My intelligence is something about me that I can't change very much.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**21)** I believe that someone like me cannot use a computer as well as other people.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)

d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**22)** My teachers think that I will not be able to use a computer.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**23)** I can learn new things, but I can't really change my basic intelligence.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**24)** A computer will make it easier for me to do things that are difficult because of my eyesight.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**25)** I will be a more independent person if I can use a computer.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**26)** Knowing how to use a computer will make me feel better about myself.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)

e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**27)** I am able to participate better in school when using a computer.
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)

**28)** I have developed good computer skills on my own (outside of school).
a) strongly disagree (1)
b) disagree (2)
c) somewhat disagree (3)
d) somewhat agree (4)
e) agree (5)
f) strongly agree (6)
g) I do not understand this question (0)